EFFECTIVE BRACING SYSTEM FOR TELECOMMUNICATION TOWERS

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B. ENG (HONS.) CIVIL ENGINEERING

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I/We* hereby declare that I/We* have checked this thesis/project* and in my/our* opinion, this thesis/project* is adequate in terms of scope and quality for the award of the Bachelor Degree of Civil Engineering

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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Thesis submitted in partial fulfillment of the requirements
for the award of the
B. Eng (Hons.) Civil Engineering

Faculty of Civil Engineering & Earth Resources

UNIVERSITI MALAYSIA PAHANG

MAY 2019

ACKNOWLEDGEMENTS

I am grateful and would like to take this opportunity to express my gratitude to those who helped me during the process completing my final year project especially my supervisor Ir. Dr. Chin Siew Choo. I am appreciated her professional advice, as well as her continuous guidance and motivation in making this research possible. I also appreciate her consistent support and effort from the first day I applied to conduct my graduate program under her supervision to these concluding moments. I am truly grateful for her tolerance of my careless mistakes, and her commitment to my research study.

My sincere thank also goes to Nor Najjatulnajihah Bt Mohd Hamizul who is my research partner for helping me in many ways and made my stay at UMP pleasant and unforgettable. I would like to acknowledge her comments and suggestions which give positive vibes for me to complete this research study.

Lastly, my sincere indebtedness to my family for their loves, motivations, and support throughout my life especially my parents who always encouraged me to achieve my goals. I am deeply indebted to everyone who has been helping me throughout my study. Thank you.

ABSTRAK

Pada masa kini, menara rangkaian komunikasi digunakan secara meluas di seluruh dunia dengan tujuan komunikasi tanpa wayar dan penyiaran. Masalah utama yang menjadi kebimbangan adalah kegagalan struktur tersebut dalam bencana alam kerana rangkaian komunikasi tanpa wayar menara jenis ini memainkan peranan penting. Oleh itu, mengkaji semua kebarangkalian bencana alam yang melampau sebelum mereka bentuk menara tersebut adalah sangat penting. Kajian ini dijalankan untuk menentukan kesan ketinggian menara yang berbeza pada ketinggian 30 m, 40 m, 50 m, dan 60 m serta pelbagai jenis sistem bentuk seperti K dan Y digunakan dengan beban angin yang bertindak di atas menara . Kelajuan angin yang digunakan dalam kajian ini adalah 33.5 m-1 dan 44.0 ms-1. Analisis angin dan simulasi menara dilakukan menggunakan perisian, STAAD. ProV8i. Keputusannya dibandingkan dari segi anjakan dan tekanan pada element menara. Berdasarkan keputusan yang diperolehi, anjakan menara dengan sistem bentuk Y didapati lebih rendah daripada sistem bentuk K kira-kira 36% sementara tekanan pada element menara dengan sistem bentuk K didapati lebih besar daripada sistem bentuk Y pada 56% pada kelajuan angin 44.0 ms-1.

ABSTRACT

Nowadays, towers with four-legged self-supporting system are widely used worldwide for wireless and broadcast communication purpose. However the major concern is the failure of such structure in a disaster since in wireless communication network these kinds of towers play a significant role. Thus, all these tendencies of extreme conditions are considered for designing such towers are of the utmost importance. This study was carried out to determine the effects of different heights of towers at 30 m, 40 m, 50 m, and 60 m as well as different types of bracing systems such as K and Y with respect to the wind load acting on the towers. The wind speeds considered in this study were 33.5 m^{-1} and 44.0 ms^{-1}. The wind modelling and simulation of the tower was conducted using commercial available software STAAD. ProV8i. The results were compared in terms of displacement and member stress. Based on the result obtained, the displacement of towers with Y bracing system was found lesser than K bracing system approximately 36% while the member stress of the tower with K bracing system was found more than Y bracing system about 56% at wind speed 44.0 ms^{-1}.

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LIST OF SYMBOLS

V_{des}	Design wind speed
V_s	Wind speed
M_d	Wind directional multiplier
$M_{z, cat}$	Terrain/ height multiplier
M_s	Shielding multiplier
M_h	Hill shape multiplier
C_{fig}	Aerodynamic shape factor
C_{dyn}	Dynamic response factor
l_h	Turbulence intensity
g_v	Peak factor
B_S	Background factor
S	Size reduction factor
E_t	Spectrum of turbulence
ζ	Ratio of structural damping to critical damping
g_r	Peak factor for resonant response

LIST OF ABBREVIATIONS

STAAD	Structural Analysis and Design

CHAPTER 1

INTRODUCTION

1.1 Background

Nowadays, the telecommunication industry plays an important role in the present societies. Thus, more attention is now being paid to telecommunication tower compared to the past and development of Malaysia's socio-economic also due to telecommunication industry contribution. The communication tower is the space structures in steel that carry communication antenna and this tower is mostly square in plan, made of standards steel angles and connected together by bolts and nuts. Then, the communication tower which is vulnerable to wind-induced oscillation and displacement, are required to study for effect in the event of wind load. Actually, communication tower can be classified into three categories which are guyed masts, monopole, and self-supporting tower. Usually, at Malaysia, self-supporting towers are generally preferred and the bracing members of communication towers are arranged in many forms with the aim to carry only tension or alternatively tension and compression. Study on the types of bracing system is important to determine the most effective and economical bracing system. Generally, the common use of the bracing system is double diagonal (X-X) bracing, V, K, W, Y, and X bracing. Also, study on the effective height of the communication tower to withstand the wind load effect.

1.2 Problem Statement

Due to the fastest growing in the telecommunication market, the number of telecommunication tower demand has been increased rapidly. Hence, the major concern of the structure is its failure in a disaster. Thus, in designing and constructing a telecommunication tower should be considering all possible extreme condition. Most of the researches have considered the effect of wind only on the towers. Since the telecommunication tower is very sensitive or prone to the presence of wind load. The higher the structure, the more it is exposed to lateral loads and the tendency to sway also increase. Furthermore, the strength of bracing in terms of arrangement has an important role to avoid the tower from failure as well. The bracing members are arranged in many forms, which to carry solely tension, or alternatively tension and compression. If the bracing is weak and wrong in arrangement the compression member would easily to buckle. Hence, the implementation of the latest technology to modeling and simulate the tower can help the engineer to analyze the effect of wind load to the tower and identify the most efficient and economical bracing system for telecommunication tower.

1.3 Objectives of the Research

The main objectives of the research include:

i. To identify the displacement effect to the communication towers in the event of wind load.
ii. To identify the most effective height of the communication tower in the event of wind load.
iii. To determine the most effective and economical bracing system for communication towers in the event of wind load.

1.4 Scope of the Research

Structural analysis and design which also known as STAAD Pro software were adopted in this research. The various bracing steel sections such as pipe section, angular section, and wind analysis had been run in STAAD Pro software to identify the most effective bracing system in the event of different wind zones. Four-legged telecommunication towers of height 30 m, 40 m, 50 m, and 60 m were designed. Both pipe and angular cross-sections considering two types of bracing patterns which were K and Y bracing at different basic wind speeds (33.5 ms^{-1} and 44 ms^{-1}) had been modeled to analyze the strength or performance of the different bracing system in different wind zones. Then, the base and top width of the tower were decided to be 5m and 2m respectively.

1.5 Significance of Research

Wind disaster is the natural disaster that destroys local resources, risks safety community and be the main factor failure of telecommunication tower as well. Thus, designing and constructing the telecommunication tower without considering the maximum wind speed that will occur at a certain zone or region area may increase the tendency failure of telecommunication tower. As structure engineer, accuracy in choosing the form of bracing system is important to increase the strength of bracing section and the compression member will not easily to buckle when the tower suddenly faces the maximum wind load. Therefore, this research was conducted to identify the most efficient and economical bracing system with modeling and simulate the telecommunication tower with various tower height at different wind speed.

1.6 Overview of the Research

Chapter one explains the background of the telecommunication tower which focusing on the different type bracing system, height of the tower and different wind speeds. In this chapter also revealing the challenges or problems that are facing by engineers to design and construct telecommunication tower. There are also other subtopics in this chapter including research objective, the scope of the research and significance of the research.

Chapter two is the literature review which needs to study and listing all the finding of researchers. The main point can be taken from the journal and articles that had studied by other authors. In this chapter also, the effect of different type of bracing systems and various heights on the displacement of communication tower is discussed. Then, the different parameters and most efficient bracing system proposed by other authors are listed and further discuss the suitability for the research. Lastly, the result and verification with experiment results are also explained and discussed in the chapter.

Chapter three is explain the research methodology that implemented in the whole process of simulation research. From obtaining material properties, modeling of the tower, analyzing the tower models, abstracting result data and validating and justifying the results of the research is clearly stated in the chapter.

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